COMPUTER-BASED INSTRUMENTATION SYSTEM FOR TEMPERATURE MEASUREMENT USING RTD IN VISUAL BASIC APPLICATION

MUHAMMAD HASBULLAH BIN RAIS

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Faculty of Electrical & Electronics Engineering

Universiti Malaysia Pahang

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Signature : _____

Author : MUHAMMAD HASBULLAH BIN RAIS

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Specially dedicated to

My beloved family and those people who have guided and inspired me

throughout my journey of education

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In the name of Allah S.W.T, The Most Gracious, The Ever Merciful. Praise is to Allah, Lord of the Universe and Peace and Prayers be upon His final Prophet and Messenger Muhammad s.a.w

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ABSTRACT

In temperature measurement, the need to get accurate and stable reading is crucial since it play major role to what we produce. Computer-based instrumentation system for temperature measurement is one way that can be used to measure temperature where the data from measurement process can be directly use for other purpose, such as calculation and data monitoring. The purpose of this project is to study about temperature measurement as well as to develop a system to ease the process of doing experiment. The system developed is named as RTD's-Temp where it is more focus on how to save time during experiment and get more systematic result. Manual method in temperature measurement is taking the data manually before finish the other things. The system is developed as alternative to conventional way of doing experiment for subject BEE4523 – Industrial Instrumentation. From the existence of this system, hope user can get benefits from it. RTD's-Temp is developed in window-based application, which can be operated in any personal computer (PC).

ABSTRAK

Dalam pengukuran suhu, adalah sangat penting untuk mendapat bacaan yang stabil dan tepat kerana ia memainkan peranan yang amat penting terhadap apa yang akan dihasilkan. Pengukuran suhu berasaskan sistem komputer merupakan salah satu cara yang boleh digunakan untuk mengukat suhu dimana hasilnya boleh digunakan terus samada untuk tujuan pengiraan atupun tujuan pemerhatian data. Tujuan projek ini dijalankan adalah untuk mengkaji mengenai penyukatan suhu disamping membangunkan satu sistem untuk memudahkan kerja semasa eksperimen dijalankan. Sistem yang dibangunkan ini dinamakan RTD's-Temp dimana ianya difokuskan bagaimana untuk menjimatkan masa semasa mejalani eksperimen serta memperoleh hasil yang sistematik. Kaedah manual yang dijalankan semasa proses pengukurn suhu dimana pengguna akan merekod data secara manual dan selepas itu barulah perkara lain seperti pengiraan dapat diselesaikan. Sistem yang dibangunkan ini adalah altenatif kepada kaedah kebiasaan semasa menjalani eksperimen untuk subjek BEE4523 – Industrial Instrumentation. Diharap dengan wujudnya sistem ini akan membawa manfaat yang banyak kepada mereka yang menggunakan sistem ini. RTD's-Temp dibangunkan berasaskan sistem windows dan boleh digunakan di mana-mana komputer peribadi.

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LIST OF ABBREVIATIONS

RTD	-	Resistance Temperature Detector
USB	-	Universal Serial Bus
DAQ or DAQ	-	Data Acquisition
PRT	-	Platinum Resistance Thermometer
°C	-	Degree Celsius
mA	-	miliampere
A	-	Ampere
Ω	-	ohm
mV	-	milivolt
I/O	-	input/output
ADC	-	analog-to-digital converter
PC	-	Personal Computer
DAC	-	digital-to-analog converter
RAM	-	Random Access Memory
CPU	-	Central Processing Unit
MHz	-	megahertz
GUI	-	Graphical User Interface
V	-	Volt
IDE	-	Integrated Development Environment
RAD	-	Rapid Application Development
MSDN	-	Microsoft Studio Network
S/H circuit	-	Sample and Hold circuit

MUX	-	Multiplexer
UUT	-	Unit Under Test
MSU	-	Master Standard Unit
γ	-	Degree of Freedom

LIST OF APPENDIXES

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

Signature : _____

Name : MOHD ANWAR BIN ZAWAWI

Date : 17 NOVEMBER 2008

CHAPTER 1

INTRODUCTION

1.1 Overview

Nowadays, there are many types of measurement that we could use to measure temperature. It is important to get accurate measurement since a wrong measurement could lead to massive destruction. The sensor used depends on what the need is, for example when we need the measurement with high accuracy, we should go for platinum RTD because it gives a more accurate reading. Other popular type of sensor such as thermocouple also can be used.

This project will concentrate on the software of the system. The method that will be used in the task is to get the reading from instruments parts and transfer it directly from the hardware to the software. The reason for using the software for the given system is to minimize the time consumption for the students to do experiment in terms of calculations and study analysis. The project is based on instrumentation, and specifically for subject Industrial Instrumentation (BEE4523). It is an education purpose project which our aim is to increase the student's interest in experiments. Student can refer to the guideline given by the lecturer (lab sheet) and at the same time, they can use the system to get better understanding. The learning station will include all the necessary calculation, for example to calculate uncertainty and other things students should know about the experiment. For plotting the graph from the system, it will help student to make sure they get the right graph. Student can sketch

the graph manually, but it takes time and therefore by using the system, the entire problem regarding the graph will be solved.

1.2 Objective Research

The objectives of the project are:

(i) To understand the concept of temperature measurement

There are various types of instrument that can be used in temperature measurement, depending on the purpose such as RTD and then we apply the concept in implementing the system.

(ii) To interface the instrument to software using hardware

Familiarize with various type of data communication to computer like USB, serial port and parallel port. Each of these has different configuration. This system will use USB as a way to connect to the computer in order to receive data from instrument.

(iii) To develop a computer-based instrumentation system used in "Temperature Instrumentation" experiment using Visual Basic application

The system will be known as "RTD's-Temp", and it will be used by student in order to save time instead of doing study analysis, which is calculation for uncertainty by their own. It takes a long time to finish the experiment, excluded the time they need to do all the necessary calculation and then finish the whole report.

1.3 Scope of Project

The scopes of the project are:

(i) RTD's-Temp can plot the graph and for do calculation for study analysis

(ii) RTD's-Temp is able to communicate to DAQ card, Advantech USB-4716 successfully via USB

User can select what mode they want to operate, either automatic or manual mode. This is a crucial part since in automatic mode; the system will automatically get the reading from the instrument with observation from user, but user still needs to initialize connection to instrument and after successful, the system will automatically receive the data according to the specification of the instrument.

(iii) Save time for doing all the calculation & plotting the graph

The main idea here is it saves a lot of time for students who are doing "Temperature Measurement" using RTD. Instead of using the conventional step, where students get all the value from experiment, do all the calculation and finally plot the graph, user can use the features of RTD's-Temp to do all the necessary calculation and plotting the graph, and yet user can still observe what happen, so they will aware about what is happening during the experiment.

1.4 Problem Statement

(i) Automated system

Error in taking reading from experiment can happen if user not clearly enough about what should he/she do.

(ii) Accuracy of result

Result for calculation use in study analysis and plotting the graph need to be accurate.

(iii) Unclear about experiment procedure

Sometime user need guidance in doing experiment, thus user need to do some finding by asking lecturer, etc but if lecturer is not there, user find it difficult to complete the experiment.

1.4.1 Current Situation

When we talk about time, people always complain about not having enough time to do something. So, some of them came with ideas to make our life easier than before. From that kind of prospective, RTD's-Temp has been created to fulfil that needs. It will help user to reduce the time consumption by doing experiment in a shorter time.

1.5 Thesis Organization

This thesis consists of five chapters. This chapter discuss about overview of project, objective research, project scope, problem statement and thesis organization.

Chapter two contains a detailed description of temperature measurement process. It will explain about the concept of temperature measurement, the application of this system and the involved component in this project.

Chapter three includes the project methodology. It will explain how the project is organized and the flow of process in completing this project. Also in this topic discusses the methodology of the hardware, instruments and software design.

Chapter four will be discussing about the result obtained in this project and a discussion about the result.

Finally, the conclusions for this project are presented in chapter five. This chapter also discusses about the recommendation for the project and for the future development.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

RTD's-Temp is a computer-based instrumentation for temperature measurement using resistance temperature detector. This system consists of three main parts which are instruments, hardware and software. Each of these parts plays significant roles to make the system successfully done the job. Figure 2.1 shows overall system of RTD's-Temp.

Figure 2.1: Overall System of RTD's-Temp

2.2 Introduction to Resistance Temperature Detector

"Resistance thermometers, also called resistance temperature detectors (RTDs), are temperature sensors that exploit the predictable change in electrical resistance of some materials with changing temperature. As they are almost invariably made of platinum, they are often called platinum resistance thermometers (PRTs). They are slowly replacing the use of thermocouples in many industrial applications below 600°C." [1]

We can categorize RTD into two different categories which are film thermometer type and wire-wound thermometer type. For the first one which is film thermometer type, it has layer of platinum on its substrate and in size approximately one micrometer. The advantages of this film thermometer type are relatively low cost and fast response. For the second one which is wire-wound thermometer type, the advantage is. It has a greater accuracy especially for wide temperature ranges. RTD itself have several wiring configuration which are two-wire configuration (figure 2.2), three-wire configuration (figure 2.3), and four-wire configuration (figure 2.4). Each of the configurations has its own advantage. The simplest resistance thermometer configuration uses two wires. It is only used when high accuracy is not required as the resistance of the connecting wires is always included with that of the sensor leading to errors in the signal. 100 meters of cable can be use for this configuration. This applies equally to balanced bridge and fixed bridge system.

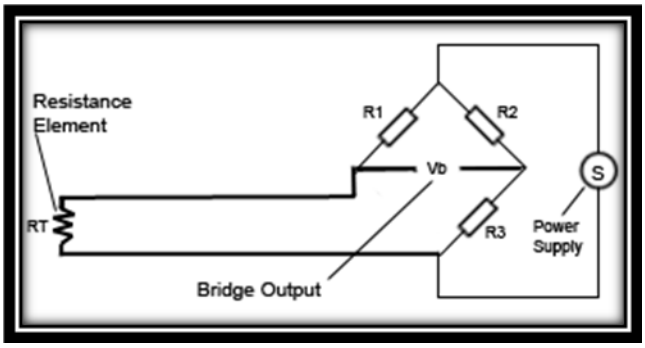

Figure 2.2: Two-Wire Configuration

In order to minimize the effect of lead resistance, three-wire configuration can be use. The configuration allows for up to 600 meters of cable.

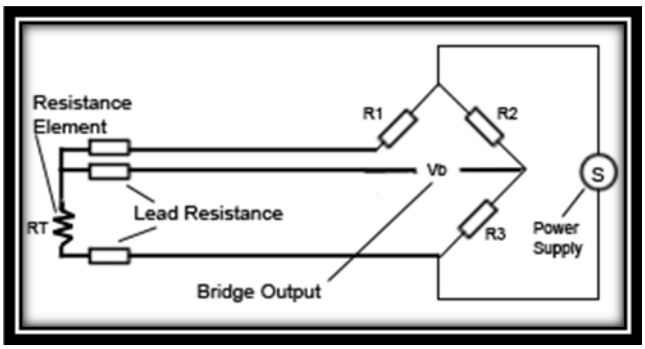

Figure 2.3: Three-Wire Configuration

The last configuration is four-wire configuration. It increases the accuracy and reliability of the resistance being measured.

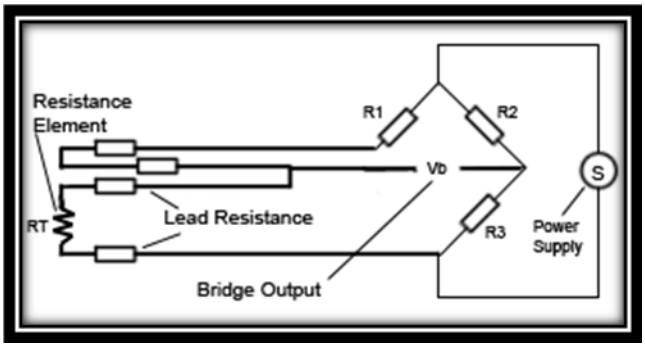

Figure 2.4: Four-Wire Configuration

If compared to thermocouple in certain cases, resistance thermometer offers greater stability, accuracy and repeatability than thermocouples. It uses electrical resistance and requires a small power source to operate. The resistance ideally varies linearly with temperature. Usually resistance thermometers are made from platinum since the advantage of using platinum is linear resistance-temperature relationship. Resistance thermometers require a small current to be passed through in order to determine the resistance. In most industries, they practice of using three-wire configuration. The advantages of using three-wire configuration are high accuracy, low drift, wide operating range, and suitability for precision applications. But there are some limitations when using RTD. If compare to thermistors, platinum RTD are